



EFFECT OF SALINITY ON GERMINATION AND SEEDLING GROWTH OF *AEGICERAS CORNICULATUM* (L.) BLANCO

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Abstract: *Aegiceras corniculatum* is an important mangrove in the old world, as well as in Bangladesh. The species is considered suitable for rehabilitating degraded mangrove, and has potential for apiculture and wastewater treatment. As salinity is a critical factor for the development of mangroves, salt (NaCl) tolerance of the species was investigated in hydroponic culture. This revealed that salinity had significantly negative impact on the germination of *A. corniculatum* propagules ($p=0.00$) but not on the seedling growth ($p>0.05$). However, lower salinities appeared to enhance seedling growth.

Key words: *Aegiceras corniculatum*, salt tolerance, mangrove, germination, seedling growth

Introduction

Aegiceras corniculatum (L.) Blanco is a large shrub or a small evergreen tree of the family Myrsinaceae. It is a cryptoviviparous, salt excluding (Saenger, 2002) and salt secreting mangrove (Primavera *et al.*, 2004). The species is one of the most widely distributed mangroves in the old world. It grows on poor, dry and saline soil (Naskar and Bakshi, 1987), usually in reclaimed areas along the embankment and edges of the creeks (Das and Alam, 2001). In Bangladesh Sundarbans, the species is mostly found in the more saline western part of the forest (Das and Alam, 2001). *A. corniculatum* is potentially useful for ecological applications such as accelerating succession, treating wastewater (Wong *et al.*, 1997) and landscaping or rehabilitation of degraded mangrove ecosystem (Debez *et al.*, 2004). It is known to produce best quality honey in the Sundarbans (Siddiqi, 2001) and thus has potential for contributing to the livelihood development of the coastal population in Bangladesh through apiculture.

Presence of salt is a characteristic feature of mangrove habitat; however mangroves are salt tolerants, not salt lovers. Salt is known to affect adversely all aspects of mangroves' life (Saenger, 2002; Hossain *et al.*, 2001; Kozłowski, 1997; Shannon *et al.*, 1994; Waisel, 1991; Ungar, 1991, 1982; Lumis *et al.*, 1973). For effective management of *A. corniculatum* it is important to study the salt tolerance, particularly optimum salt tolerance range of the species. As NaCl is mostly responsible for the salinity in seawater (86%; Duxbury and Duxbury, 1997) and thus in mangrove substrate, in this text salt means common salt (NaCl). As germination of seed/propagule is the most critical event in a plant's life and seedling stage is the most critical stage (McKee, 1996), effects of salt on the germination of propagules and seedling growth were studied for the salt tolerance of *A. corniculatum*. In nature, salinity changes gradually with season. Thus, seedling

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growth was studied at salinities in which they were germinated and in gradually increasing saline conditions.

Materials and Methods

The experiment was carried out in hydroponic culture as it permits efficient control of the salinity of the growth medium and nutrient supply to experimental plants. Mature propagules of *A. corniculatum* were collected from the plants in the Sundarbans Reserved Forest in September 2004. Experiments were carried out using CRD. Germination of propagules was studied using 10 salinity levels (0 to 45 ppt at 5 ppt intervals) with 3 replications, each replication containing 30 propagules. Seedling growth in constant salinity was carried out in four salinity levels (0 to 15 ppt at 5 ppt intervals) and that in gradually increasing salinity was conducted in seven salinity levels (0 to 36 ppt at 6 ppt intervals). Each treatment was applied with seven replications, one seedling representing a replication. Details of the germination and seedling growth experiment are presented below.

Effect of salt on the propagule germination: A 100 ppt stock solution of common salt (NaCl) was prepared. Using this stock, working solution of 0 to 45 ppt salinities at 5 ppt interval were prepared. Salinity of the working solution was checked with a hand held temperature compensated salinity refractometer. One third of a plastic bowl (diameter 30 cm and depth 14 cm) was filled with sand. Salt solution was poured into the bowl until a thin layer of water on the sand surface was visible. Following this process for 10 salinity levels (0 – 45 ppt at 5 ppt intervals), each with 3 replications, a total of 30 plastic bowls were prepared. In each bowl 30 propagules were sown in September 2004. The water level in bowls was checked and corrected once daily by adding tap water. Initiation of root was considered as the indicator of germination. The germination of the propagule was recorded at 2 days interval until there was no fresh germination.

Effect of salt on the seedling growth: Containers for seedling growth study was prepared as in Fig-1. Nutrient solution was a modified Hoagland's solution, $\text{MnSO}_4 \cdot \text{H}_2\text{O}$ and $(\text{NH}_4)_6\text{Mo}_7.4\text{H}_2\text{O}$ being used instead of $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$ and $\text{H}_2\text{MoO}_4 \cdot \text{H}_2\text{O}$. Such modifications are widely accepted (Jones, 1997). Preparation of the nutrient solutions and application of the treatments are given below:

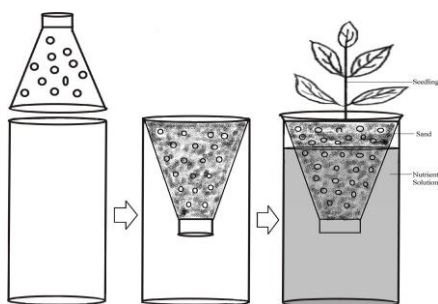


Fig. 1. Pot Preparation for growth study.

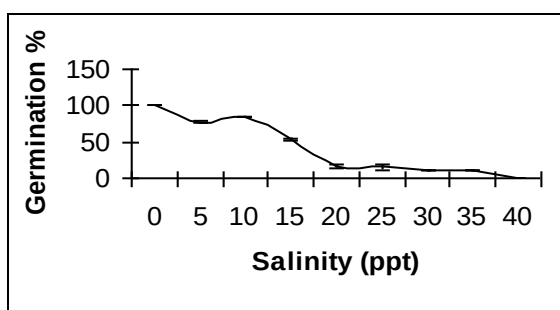


Fig. 2. Effect of salinity on the germination of *A. corniculatum* propagules.

Growing seedlings in nutrient solution with salinity corresponding to that of germination media: This study had to be kept limited to 4 salinity treatments viz., 0, 5, 10 and 15 ppt as germination in salinities ≥ 20 ppt was poor or absent. For a known volume of nutrient solution with a particular salinity, required volume of nutrient solutions was determined using Table 3.1. Stock solutions of

nutrients and salt were taken in a graduated container and tap water was added to make desired volume nutrient solutions with 0, 5, 10 and 15 ppt salinities. For each salinity level, 700 ml of nutrient solution was poured into each of the seven containers. Level of solution was marked on the bottle. Seven healthy seedlings from each salinity treatment (0, 5, 10 and 15 ppt) for germination were uprooted carefully, washed in running tap water, blotted dry and weighed for initial biomass with a digital top loading balance. Each seedling, representing a replication, was transplanted in a container having nutrient solution with salinity corresponding to that of germination substrate. To maintain uniform salinity, level of solution was checked and corrected by adding tap water once daily. Nutrient solution was flashed out and renewed weekly. This study was carried out over a period of six months from November 2004 to May 2005.

Growing seedlings in gradually increasing saline conditions: Firstly, nutrient solution without salt was prepared using Table 1. From this, 700 ml solution was poured into each of 63 containers. Biomass of 63 healthy seedlings (germinated in fresh water condition) was measured as described above. Each of these seedlings was transplanted in a container. Salinity of the solution was increased by 2ppt on every third day to produce nutrient solution with 0-36 at 6 ppt intervals. To do this required volume of stock solution for increasing salinity of 700 ml nutrient solution by 2 ppt was determined. On the third day after transplanting seedlings, this volume of stock salt solution was added in 56 containers. In the other seven containers seedlings were grown without salt. The procedure was repeated on the every third-day. Thus, after nine days 56 containers had nutrient solution with 6 ppt salinity. In the following third-day stock salt solution was added in 49 containers to increase the salinity. By this procedure over a period 54 days nutrient solutions with salinities 0 to 36 ppt at 6 ppt intervals were produced. In each salinity level there were seven seedlings growing- each representing a replication. Throughout the study period, salinity was maintained by daily checking and replenishing water loss by adding tap water. Nutrient solution was flashed out and renewed weekly. This experiment was carried out over a period of five months from December 2004 to May 2005.

At the end of the experiment seedlings were uprooted and green biomass was measured using a top loading digital balance. Seedling growth during the experimental period was calculated by subtracting initial biomass from the final biomass and was converted into percentage of the initial biomass for further analysis.

Table1. Constitutions of stock nutrient solution used in the experiment.

Salt	For stock solution (g l ⁻¹)	To Use (ml l ⁻¹)
NH ₄ H ₂ PO ₄	115.00	1.00
KNO ₃	101.11	6.00
Ca(NO ₃) ₂ .4H ₂ O	236.20	4.00
MgSO ₄ .7H ₂ O	246.50	2.00
MnSO ₄ .H ₂ O	0.57	1.00
H ₃ BOP ₄	2.86	1.00
CuSO ₄ .5H ₂ O	0.08	1.00
(NH ₄) ₆ Mo ₇ .4H ₂ O	0.02	1.00
ZnSO ₄ .5H ₂ O	0.22	1.00
C ₆ H ₈ O ₇ FeNH ₃	5.00	1.00

Statistical Analysis:

Data were analyzed using minitab 11.2 Statistical package and MS Excel.

Results

Effect of salinity on the germination of *A. corniculatum* propagules: Effect of salinity on the germination is presented in Fig. 2. Analysis of data revealed that salinity had highly significant negative effect on the germination of *A. corniculatum* propagules ($p = 0.00$, and $r = -0.94$). Germination was the highest (100%) at 0 ppt salinity, satisfactory (60%) up to 15 ppt salinity. However germination between salinities 10 ppt and 20 ppt germination decreased sharply with the increase in salinities. Germination % within the range of 25 to 35 ppt salinity was very low (<14%) but did not vary significantly and no germination was observed at 40 ppt salinity.

Effect of salinity on the growth of *A. corniculatum* seedlings: Effect of salinity on the growth of *A. corniculatum* seedlings has been presented in Fig 3(a, b). It was observed that when *A. corniculatum* seedlings were germinated and grown in same salinities, salinity had no significant ($p > 0.05$) effect on the biomass production (Fig. 3a). The same ($p > 0.05$) was true for seedlings germinated in fresh water condition and grown in gradually increasing saline condition (Fig. 3b). However it was observed that low salinities, up to 5 ppt for the first and up to 12 ppt in the latter condition, enhanced growth of the seedlings.

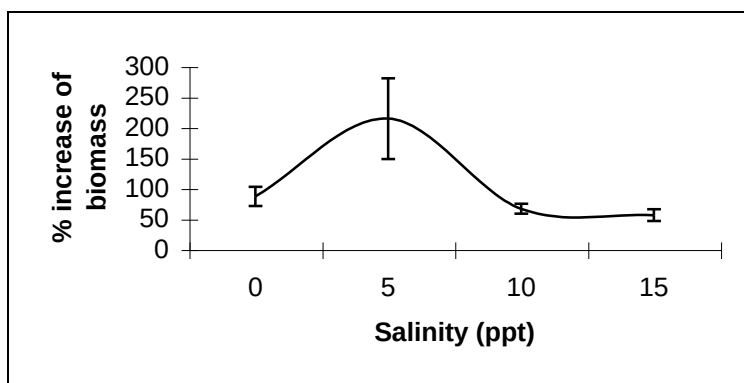


Fig.3a. Effect of salinity on the growth of *A. corniculatum* seedlings germinated and grown in same salinity

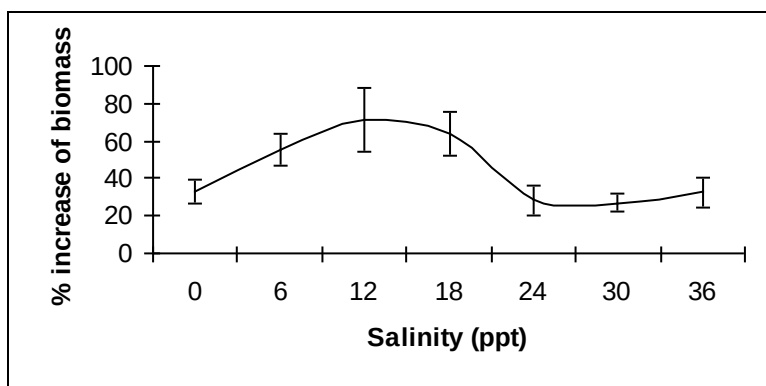


Fig.3b. Effect of gradual increase in salinity on the growth of *A. corniculatum* seedlings.

Discussion

Only a few relevant published literatures could be traced to validate the present study. In the only literature regarding the germination of *A. corniculatum* propagules Siddiqi (2001) reported 100% germination success in fresh water condition in the nursery. This is exactly same to the finding of this study under the same condition. However, Siddiqi (2001) did not study the effect of higher salinities on the germination. Saenger (2002) reported that *A. corniculatum* is very efficient in excluding salt while absorbing water and mangroves have this salt exclusion mechanism in their roots. Therefore, salt exclusion mechanism operates only after the initiation of root and thus the plant remain susceptible to salt during germination. With other mangroves several authors (e.g. Siddiqi and Islam, 1988; Hoque *et al.*, 1999; Ball and Pidsley, 1995, Ungar, 1995, 1991) have reported negative relationship between salinity and seed germination, which support the finding of the present observation.

No significant effect of salt was observed on the growth of *A. corniculatum*. This finding contradicts with Ball and Farquhar (1984) and Burchett *et al.* (1989). Ball and Farquhar (1984) observed a significantly negative impact of salt on the growth of *A. corniculatum* seedlings. Burchett *et al.* (1989) reported higher metabolic cost and thus reduced growth at higher salinities in *A. corniculatum*. However, Hogarth (1999) observed that individuals of a species collected from different environments may response differently to varying salt concentration.

Highest seedling growth was observed at 5 ppt salinity when seedlings were germinated and grown in same saline condition and at 12 ppt when seedlings were germinated in freshwater condition and grown in gradually increasing saline condition. These indicate that lower salinities enhanced seedling growth to some extent. Similar result was observed by Joshi and Ghosh (2003) who reported 13.01 ppt salinity as ecological optima for *A. corniculatum* in the Indian part of the Sundarbans. Burchett *et al.* (1989) observed the maximum growth of *A. corniculatum* in 25% (8.75 ppt salinity) seawater. Similar type of remark was made by Ball and Anderson (1986) for sympatric species, *Avicennia marina* in Australia.

Conclusion

From this experiment it can be concluded that salinity has significant negative effect on the germination of *A. corniculatum* propagules but not on the seedling growth. Both in terms of germination and growth, salinity up to 15 ppt could be considered as optimum for *A. corniculatum* in Bangladesh. As *A. corniculatum* seedlings can successfully cope with higher salinities it is recommended that for planting the species in highly saline areas, nursery raised seedlings should be used.

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